

SQUIDS OF THE GENUS *ABRALIA* (CEPHALOPODA) FROM THE CENTRAL EQUATORIAL PACIFIC WITH A DESCRIPTION OF *ABRALIA HEMINUCHALIS*, NEW SPECIES

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ABSTRACT

Abralia trigonura Berry, 1913, from the Hawaiian Islands is redescribed and a neotype designated. A closely related new species *Abralia heminuchalis* from the central equatorial Pacific is described. Material from a new area of distribution for *Abralia similis* Okutani and Tsuchiya, 1987, is discussed. Material for the rare *Abralia astrosticta* Berry, 1909, is reported, accompanied by a description of a specimen from the Marshall Islands by the late Gilbert L. Voss. All the species examined are illustrated and compared, and observations on immature animals noted.

Between 1967 and 1970, while preparing a reference cephalopod collection for the Bureau of Commercial Fisheries Biological Laboratory (now the Honolulu Laboratory, Southwest Center of the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, NOAA), over 5,000 oegopsid squids were identified as belonging to the genus *Abralia*, family Enoploteuthidae. The four species found were *A. trigonura* Berry, 1913, *A. astrosticta* Berry, 1909, and two un-named species then. One of the them has been described as *A. similis* Okutani and Tsuchiya, 1987, the other presented here as *Abralia heminuchalis*, n. sp. Of the more specimens identified, approximately 1,145 were *A. trigonura*, 2,367 *A. heminuchalis*, 1,484 *A. similis* and 96 *A. astrosticta*.

The samples were taken mainly with a modified Cobb trawl, a 10-foot Isaacs-Kidd trawl, or a Nanaimo trawl during the cruises of several research vessels operated by the laboratory. Fishing generally took place at night, mostly at depths between 50 and 100 m. The bulk of the material was collected from Hawaiian waters and the central equatorial area of the Pacific.

The collection at the Honolulu Laboratory remained unattended for several years after the completion of this study, resulting in the loss of many specimens by desiccation. Undamaged material was subsequently transferred to the United States National Museum of Natural History (USNM), Smithsonian Institution, Washington, D.C. Examination of these holdings at the USNM indicates that the *Abralia* species discussed here are represented there by some of the original material and material from other sources.

METHODS

Methods of presenting squid measurements, counts and computation of indices conform to those proposed by Voss (1963) and Roper (1966): ML (mantle length), MWI (mantle width index), HWI (head width index), FLI (fin length index), FWI (fin width index), ALI (arm length index), TLI (tentacle length index), CLI (club length index) and SPLI (spermatophore length index). Arm length is measured from the first basal hook or sucker to tip of arm. Terminology agrees with that generally accepted for squids; any new term introduced is defined or described.

In the material examined research vessels are abbreviated: HMS (HUGH M. SMITH), CHG (CHARLES H. GILBERT) and TC (TOWNSEND CROMWELL).

Enoploteuthidae Pfeffer, 1900

Enoploteuthinae Pfeffer, 1912

Abralia Gray, 1849

Abralia (*Heterabralia*) Tsuchiya and Okutani, 1988

Abralia (Heterabralia) trigonura Berry, 1913

Figure 1: Tables 1, 2

Abralia species Berry, 1909, p. 419 (locality record only) *Abralia trigonura* Berry, 1913, p. 565; Berry, 1914a, p. 329; Grimpe, 1931, p. 165; Clarke, 1966, p. 173; Roper and Young, 1975, p. 11; Young, 1978, p. 588; Young and Arnold, 1982, p. 135; Young and Harman, 1985, p. 183; *Abralia (Asteroteuthis) trigonura* Nesis, 1982, p. 168, 1987, p. 179; Nesis and Nikitina, 1987, p. 1701; *Abralia (Heterabralia) trigonura* Tsuchiya and Okutani, 1988, p. 129.

Material Examined.—Neotype: 1 male ML 37 mm, TC 32, sta. 56, 21°22.4'N, 158°14.6'W, Aug. 19, 1967, depth 97–179 m, USNM 730631.—5 females, ML 22–35 mm, 3 males ML 27, 9 juveniles, ML 13–18 mm, HMS 47, sta. 2, 21°24'N, 158°23'W, Oct. 9, 1950, depth 914 m, USNM 813132.—4 females, ML 22–31 mm, 1 male ML 27 mm, HMS 47, sta. 8, 21°32'N, 158°22'W, Oct. 11, 1958, depth 990 m, USNM 813133.—3 females, ML 41–50 mm, TC 7, sta. 7, off Kawaihae, island of Hawaii, Aug. 14, 1964, depth 37–46 m, USNM 813116.—3 males, ML 31–37 mm, TC 7, sta. 28, off Kailua, island of Hawaii, Aug. 23, 1964, depth 100–150 m, USNM 313114.—11 females, ML 38–50 mm, 1 male 35 mm, same lot as neotype, USNM 817619.—3 juveniles, ML 8–10 mm, TC 31, sta. 6, off Waianae, island of Oahu, May 13, 1967, depth 17 m, USNM 813077.

Description.—Females 22–50 mm ML, males 24–37 mm ML. Vesiculate tail about $\frac{1}{5}$ of ventral ML. Dorsal posterior end of mantle has pale lozenge-shaped area in freshly preserved specimens only (Fig. 1M).

Fins large, length 71% of ML, width 125% of ML.

Funnel organ: dorsal pad inverted V, limbs broad with small pointed papilla, lateral ridges low; ventral pad oval, produced anteriorly (Fig. 1L). No ridges or papillae mentioned by Berry (1913, 1914a), possibly on account of the poor condition of the holotype.

Arms moderate in length (ALI 26.9–47.4), arm order variable, 4.3 = 2.1 most common in both sexes. Arms each with 9–15 hooks and a series of suckers on distal third of arm. Hooks: base triangular, tip curved (Fig. 1C). One female (ML 50 mm) had 50, 41, 36 and 18 distal suckers on arms I–IV, respectively. Proximal third of arm suckers on long stalks, about 20–22 teeth around margin of inner ring (6 or more broad teeth on distal margin), shelf behind inner ring proximally with notch (marked x, Fig. 1D), several rows of pegs on outer ring; distal suckers globular, small aperture. Arm suckers biserial, may appear arranged in three rows in some arms. Quadriseserial arrangement described in *A. veranyi* (Adam, 1952) and figured by Tsuchiya and Okutani (1988, fig. 9) not observed. Arm IV generally lacks globular suckers; rarely with 2 or 3 following regular sucker rows.

Left arm IV of male hectocotylized; ventral semicircular lappet and smaller dorsal lappet present (Fig. 1I). Both lappets thick and tend to stay folded medially. Distal suckers absent.

Tentacles long (TLI 80.0–150.0). Club not expanded (Fig. 1J). Carpal cluster oval in outline, with 3–5 smooth-ringed suckers. Manus with 2–4 ventral hooks, 6–8 dorsal suckers in 2 rows (Fig. 1G). Manal suckers on long stalks, about 30 blunt teeth on inner ring, small pegs on outer ring (Fig. 1E). Dactyl suckers quadriseserial (17–20 rows), few irregular teeth on inner ring margin. A ventral flap from distal portion of carpal cluster to opposite second hook. Dorsal protective membrane extends from 1st club sucker to 1st row of dactyl suckers, much narrower anteriorly.

Integumentary photophores numerous; larger white ones with dark edge and smaller, darker ones of varying sizes; 3 types known (Young and Arnold, 1982), only 2 distinguished in preservation. Photophores most numerous on ventral side of mantle, fewer toward dorsal side, few on fin surface, 3–4 on margins of vesiculate tail, none on median ventral area. On mantle ventrally, white photophores set widely apart (antero-posterior rows), smaller dark photophores scattered around and between white ones.

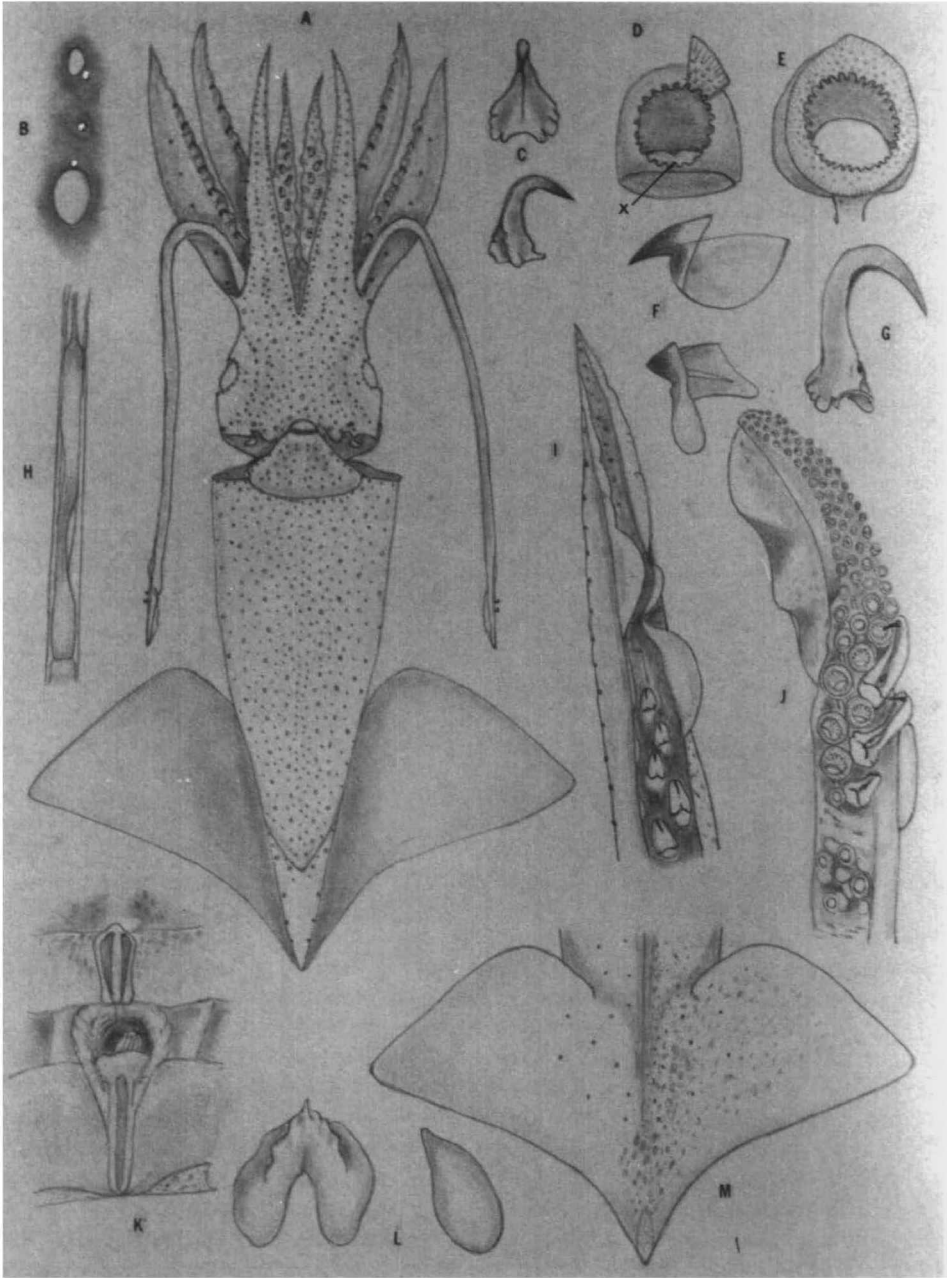


Figure 1. *Abralia trigonura* Berry, 1913. A. Female, ML 41 mm, ventral view, USNM 813116, TC sta. 7-7; B. Eye light organs; C. Arm hook, 2 views; D. Arm sucker ring, inner shelf (x); E. Tentacular club sucker (manus); F. Mandibles, upper and lower; G. Largest tentacular sucker; H. Cement gland of spermatophore; I. Hectocotylus (left arm IV), adult male, ML 37 mm, USNM 730631, TC sta. 32-56; J. Left tentacular club; K. Seminal receptacle, adult female; L. Funnel organ; M. Fins, dorsal view, right half with both light organs and chromatophores shown.

Table 1. *Abralia trigonura*, measurements (in millimeters), counts, and indices

Cruise station	TC 7		Sta. 56		HMS 47								HMS 47							
	Sta. 7		Sta. 56		Sta. 2		Sta. 8		Sta. 2		Sta. 8		Sta. 2		Sta. 8		Sta. 2		Sta. 8	
Sex	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
ML	50	49	48	47	45	42	41	40	39	38	35	31	30	28	26	25	23	22		
MWI	34.9	34.7	31.3	31.9	33.3	35.7	34.1	37.5	35.6	36.8	34.3	35.5	36.7	42.9	38.4	40.0	43.5	40.9		
HWI	30.0	34.7	31.3	31.9	31.1	33.3	34.1	35.5	30.8	34.2	31.4	32.3	33.3	35.7	34.6	32.0	34.8	31.8		
FLI	68.0	67.3	68.1	66.0	64.4	71.4	65.9	70.0	64.1	65.8	68.6	64.6	66.7	64.3	61.5	64.0	69.6	68.2		
FWI	92.0	98.0	95.8	89.4	88.9	95.2	97.6	95.0	97.4	94.7	108.6	109.7	100.0	108.1	100.0	118.2	100.0	109.1		
ALI																				
I	34.0	32.7	33.3	36.1	35.6	35.7	36.6	35.0	35.9	39.5	31.4	35.5	33.3	32.2	30.8	—	30.4	27.3		
II	40.0	42.9	35.4	42.6	42.2	42.9	43.9	37.5	41.0	44.7	34.3	38.7	36.7	—	34.6	36.0	34.8	31.8		
III	38.0	42.9	39.6	42.6	40.0	40.5	36.6	37.5	41.0	42.1	34.3	38.7	36.7	39.2	34.6	34.0	34.8	34.0		
IV	36.0	42.9	39.6	42.6	42.2	40.5	41.5	42.5	46.2	47.4	37.1	41.9	36.7	39.2	38.4	36.0	39.1	36.0		
Arm hooks																				
I	12	9	12	13	12	11	10	10	11	11	11	11	11	13	12	—	10	12		
II	13	13	13	13	14	12	13	12	12	13	13	13	13	—	14	14	14	13		
III	12	12	11	12	12	12	14	10	11	13	12	11	10	12	13	12	11	13		
IV	14	14	14	13	14	13	12	12	12	13	14	13	13	15	14	12	13	14		
TLI	80.0	112.2	106.3	119.1	108.9	119.0	104.9	120.0	156.4	113.2	85.0	119.4	83.3	150.0	92.3	92.0	91.3	118.2		
CLI	18.0	22.4	20.8	19.1	22.2	21.4	22.0	22.5	25.6	22.4	20.0	24.2	18.3	23.2	19.2	20.0	17.4	22.7		
Right-left																				
Club hooks	3-3	3-3	3-3	3-—	4-3	4-4	4-4	3-3	3-—	3-3	3-3	3-4	4-3	3-3	3-3	3-—	3-3	3-3		
Carpal suckers	4-4	4-4	5-5	5-—	5-5	5-5	5-5	4-5	4-—	4-4	4-4	3-5	5-4	5-5	5-4	3-—	5-5	3-3		

Ventral side of funnel with 2 broad strips (narrow median space present), short strip on each side, single white photophore in each strip. Cluster of photophores close to bridles.

On head ventrally a broad band of photophores (8-10 white surrounded by smaller dark organs) extends from funnel groove area, 1st and 2nd nuchal folds, to base of arms IV. Within funnel groove 2-3 isolated organs on each side present, small triangular space in front of bridles. Semicircular row extends from near 3rd nuchal fold, spreads laterally and medially to base of arm IV. Few small light organs between semicircular row and eyelid.

Arm IV photophores: a row on aboral edge; another along base of tentacular sheath (white photophores distributed regularly in these rows); third row, small ones at edge of tentacular sheath, ends at $\frac{3}{4}$ of arm length. Arm III: one white photophore near proximal end of keel, about 6 evenly-spaced small light organs deeply embedded in base of keel; 2 or 3 small photophores on dorsal side near arm base. Arm II: one small light organ at arm base. Arm I: no light organs.

Five eye light organs (Fig. 1B): 2 large oval dull pink terminal organs (posterior organ 3 times size of anterior), 3 much smaller round amber-colored organs between them (middle organ slightly larger). First and third round organs usually adjacent to end organs.

Gladius, with strong rachis, pointed anteriorly. Keel rounded dorsally on anterior third of gladius length (GL), a sharp ridge posteriorly. Vane length about 70% of GL, total width about 25% of GL, margins slightly concave demarcated by rounded angle. Conus small and broadly rounded.

Mandibles typical enoploteuthid with three supporting ribs on gular plate of lower mandible (Fig. 1F).

Spermatophores small (7.0 mm total length), slender (0.25 mm). Spiral filament 2.1 mm long, 2-3 coils behind cap. Cement gland cylindrical, 0.9 mm long (Fig. 1H). Sperm reservoir 4 mm long. Spermatophores deposited in sac-like seminal receptacle posterior to nuchal cartilage between stellate ganglia (Fig. 1K). Pigmented round spot on middorsal line of mantle indicates presence of sac below (in freshly preserved squids only).

Ink sac slender, duct with bulb-like expansion before entry into rectum.

Growth. — At 8 mm ML only suckers present on club, carpal suckers differentiated. At 10 mm ML one club hook present. From 11-12 mm ML more hooks start to appear. At 18 mm ML 2 or 3 suckers present in proximal part of some arms. At 22 mm ML most of the arm hooks developed. At 20 mm ML lappets on left arm IV of males present and at 23 mm ML spermatophores developed. At 24 mm ML female may have sperm reservoirs in the seminal receptacle. White photophores first to appear. Early larval history (1.0-7.5 mm ML) described by Young and Harman (1985).

Distribution. — *A. trigonura* is endemic to Hawaiian waters. It is a member of a peculiar community of small micronektonic animals existing at the interface of neritic and oceanic ecosystems in Hawaiian waters (Reid et al., in press). This mesopelagic boundary community appears to consist of many endemic species. Almost 800 specimens were captured at a single site off northeastern Molokai trawled over 500 m bottom isobath. In an earlier paper Young (1978) reported collecting *A. trigonura* material during daytime hauls at depths between 450 and 560 m and nighttime between 30 and 200 m.

Remarks. — Since the holotype of *A. trigonura* no longer is extant, I designate a 37 mm ML male as the neotype. Berry (1914a) considered *A. trigonura* related to *A. andamanica* Goodrich, 1896, from the Bay of Bengal. Sasaki (1916, 1929)

Table 2. Collecting data of *Abralia trigonura*

Cruise No.	Sta. No.	Date	Position/locality	Time	Depth (m)	Number (sp.)	ML (mm)
HMS-47	2	10/09/58	21°24.0', 158°23.0'	2025-2300	914	17	13-35
	8	10/11/58	21°32.0', 158°22.0'	2008-2215	990	6	18-27
TC-7	5	8/12/64	off Waianae, Oahu	1958-2207	780-183	283	12-44
	7	8/14/64	off Kawaihai, Hawaii	1910-2044	37-46	3	38-50
	10	8/15/64	off Milolii, Hawaii	1932-1648	360-420	11	16-48
	12	8/16/64	off Milolii, Hawaii	1917-2056	86-137	3	22-32
	18	8/19/64	off Keahole Pt., Hawaii	2030-2136	0-256	3	14-25
	23	8/21/64	off Kailua, Hawaii	2020-2155	79-82	25	11-25
	26	8/23/64	off Kailua, Hawaii	0210-0347	73-97	5	22-26
	28	8/23/64	off Kawaihai, Hawaii	2005-2140	104-152	10	8-44
TC-31	6	5/13/67	off Waianae, Oahu	—	17	3	8-10
TC-32	2	7/12/67	21°22.5'N, 158°13.5'W	1953-0153	65-110	42	17-37
	3	7/13/67	21°22.5'N, 158°13.5'W	0355-0955	15-25	14	24-44
	4	7/13/67	21°20.9'N, 158°13.1'W	1146-1746	75-107	22	16-38
	5	7/13/67	21°21.7'N, 158°13.3'W	1946-0146	16-26	10	6-9
	6	7/14/67	21°21.7'N, 158°13.3'W	0354-0954	83-124	33	6-32
	8	7/14/67	21°22.0'N, 158°15.5'W	1954-0154	86-129	53	15-40
	9	7/15/67	21°21.5'N, 158°13.5'W	0354-0954	17-25	17	16-48
	10	7/15/67	21°21.5'N, 158°13.5'W	1154-1754	85-123	7	22-36
	11	7/15/67	21°21.4'N, 158°12.7'W	1950-0150	15-20	5	8-33
	12	7/16/67	21°22.8'N, 158°14.6'W	0403-1003	76-94	42	6-42
	15	7/17/67	21°20.3'N, 158°12.2'W	0352-0952	16-30	22+	6-33
	17	7/19/67	21°21.2'N, 158°12.4'W	1946-0146	17-26	10	4-9
	18	7/20/67	21°22.2'N, 158°5.7'W	0354-0954	99-113	8	13-24
	20	7/21/67	20°58.5'N, 158°39.2'W	0354-0954	88-110	14	14-34
	22	7/21/67	21°02.0'N, 158°29.7'W	1952-0152	87-117	4	18-27
	25	7/23/67	20°59.9'N, 158°29.8'W	0353-0953	78-122	6	14-26
	28	7/25/67	20°58.7'N, 158°33.7'W	1952-0152	92-122	200+	7-37
	29	7/26/67	20°59.5'N, 158°31.5'W	0343-0755	8-60	1	26
	30	8/12/67	20°59.8'N, 158°29.7'W	1944-0144	8-26	4	7-8
	31	8/13/67	20°59.6'N, 158°29.3'W	0354-0954	80-121	9	11-26
	32	8/13/67	20°58.7'N, 158°28.8'W	1148-1748	16-21	1	19
	33	8/13/67	20°58.8'N, 158°28.4'W	1950-0150	83-99	25	21-48
	34	8/14/67	21°01.0'N, 158°39.9'W	0342-0942	7-21	1	8
	37	8/15/67	20°59.1'N, 158°12.7'W	0354-0954	55-123	20+	11-23
	38	8/15/67	20°58.7'N, 158°27.9'W	1144-1744	8-25	2	11
	39	8/15/67	20°59.6'N, 158°29.3'W	1953-0153	63-101	37	12-31
	43	8/17/67	20°59.4'N, 158°29.8'W	1946-0146	8-25	1	8
	44	8/18/67	21°00.1'N, 158°29.1'W	0353-0953	72-118	6	10-15
	46	8/18/67	20°57.6'N, 158°28.7'W	1951-0151	77-118	21	9-28
	47	8/19/67	20°59.8'N, 158°28.0'W	0341-0941	8-28	3	10-22
	52	8/21/67	20°19.9'N, 158°14.2'W	1942-0142	18-27	3	6-9
	53	8/22/67	21°21.6'N, 158°13.8'W	0349-0949	94-110	31	22-47
	54	8/22/67	21°21.7'N, 158°14.9'W	1142-1742	15-21	7	23-45
	55	8/22/67	21°21.6'N, 158°15.7'W	1951-0151	91-122	20	24-43
	56	8/23/67	21°22.4'N, 158°14.6'W	1952-0152	97-179	43	24-46
	57	8/24/67	21°21.9'N, 158°14.3'W	0344-0944	18-21	6	20-37
	69	9/16/67	19°45.1'N, 156°08.6'W	0402-1002	105-170	9	14-35
	71	9/17/67	19°18.5'N, 156°00.1'W	0352-0952	95-110	7	15-32
	79	9/23/67	21°20.2'N, 158°14.7'W	0350-0950	45-78	9	4-40
	85	9/25/67	21°20.2'N, 158°12.8'W	0300-0944	13-18	1	7

described 2 specimens from Odawara, Sagami Bay, as *A. andamanica*. Grime (1931) was of the opinion that Sasaki's specimens were possibly the same as his *A. robsoni* (holotype exists, but undescribed). Voss (1963) stated *A. adamanica* is possibly represented by a Japanese and a Hawaiian subspecies (probably re-

ferring to *A. trigonura*). Okutani (1974) identified specimens from the east Pacific as *A. andamanica*, Kubota, Iizuka and Okutani (1982) considered the Japanese form a possible subspecies, *A. andamanica robsoni*. Amelikhina (1983) designated her material as *A. andamanica* f. *robsoni*.

Although *A. trigonura* closely resembles *A. andamanica* (sensu Voss) some differences exist. The 9–10 photophore rows on the ventral side of the head in *A. andamanica* are not discernible in *A. trigonura*, except for the semicircular row near each eye.

A. trigonura has wider fins (FWI 88.9–125.1) than Philippine *andamanica* (FWI 69.8–86.0) and approach those of Okutani's east Pacific *andamanica* (FWI 105.6–111.0). Sasaki's *andamanica* fins (FWI 74.2–99.2) are narrower than in *A. trigonura*, but within the range of Philippine *andamanica*. *A. trigonura* fin length (FLI 61.5–71.44) is comparable to Philippine *andamanica* (FLI 62.5–74.3) and Japanese *andamanica* (Sasaki, FLI 67.6–70.2). According to the *A. andamanica* data of Kubota et al. (1982, figs. 6 and 7) Philippine *andamanica* has narrower and longer fins than their material. The arm tips of Philippine *andamanica* are "whip-like" (Voss, 1963, fig. 21d); not so in *A. trigonura*. In *A. trigonura* the predominant arm formula is 4.3 = 2.1, in Philippine and Japanese *andamanica* it is 2.4.3.1. The dentition of arm suckers is different: dentate all around, inner shelf notched (Fig. 1D) in *A. trigonura*; without teeth on the proximal half and without a notch in Philippine *andamanica* (Voss, 1963, fig. 21g). Sasaki's specimens (Sasaki, 1929, text fig. 123C) are dentate all around, 4 to 5 teeth larger distally, a very wide tooth on each side (absent in *A. trigonura*), inner shelf notched as in *A. trigonura*. Club can have 3 to 4 hooks; 4 hooks predominate in *A. trigonura* (77.9%), 3 hooks in *A. andamanica* (54.5%). Carpal suckers: 4 carpal suckers predominate in *A. andamanica* (97%), 5 suckers in *A. trigonura* (56%). *A. trigonura* produces larger spermatophores (SPLI 18.9, 37 mm ML male). From a 33 mm ML male, Amelikhina (1983) reported spermatophore length of 4.8 mm (SPLI 14.5) in the Indian Ocean *andamanica*.

In spite of having many characters in common with *A. andamanica*, *A. trigonura* also has some distinctive features. The land associated habitat suggests that restricted gene flow relative to ocean species may have resulted in greater genetic differentiation within the *A. andamanica* group. Direct comparison of large samples from different regions are needed to finally resolve the systematic status of these populations.

Abralia (Heterabralia) heminuchalis new species

Figure 2: Tables 3, 4

Material Examined.—Holotype: female, ML 37 mm, HMS 47, sta. 51, 0°44'S, 149°46'W, Nov. 2, 1958, depth 576 m, USNM 729683. —Paratypes: 3 males, ML 27–32 mm, 5 females ML 31–35 mm, 8 juveniles, ML 17–20 mm, HMS 47, sta. 51, 0°44'S, 149°46'W, Nov. 2, 1958, depth 576 m, USNM 729719. —Other material: 8 males, ML 21–31 mm, 7 females, ML 22–34 mm, HMS 47, sta. 51, 0°44'S, 149°46'W, Nov. 2, 1958, depth 576 m, USNM 814438. —11 males, ML 26–30 mm, HMS 47, sta. 58, 2°56'N, 150°03'W, Nov. 4, 1958, depth 54 m, USNM 814492. —1 female, ML 32 mm, HMS 35, sta. 168, 4°19'N, 160°08'W, Sept. 10, 1956, depth 200 m, USNM 814450. —2 males, ML 26–39 mm, HMS 35, sta. 95, 15°44'S, 142°59.8'W, Aug. 28, 1958, depth 200 m, USNM 814461. —1 female, ML 41 mm, HMS 31, sta. 176, 1°07'N, 159°56'W, Dec. 5, 1955, USNM 814444.

Description.—Females 28–37 mm ML, males 25–32 mm ML. Mantle widest at anterior edge (MWI 33.3–44.8). Vesiculate tail $\frac{1}{5}$ to $\frac{1}{6}$ of ML.

Fins long (FLI 60.6–71.4), wide (FWI 103.0–117.0). Lozenge-shaped translucent area between fins at posterior middorsal tip present in newly preserved specimens only (Fig. 2M).

Head narrower than mantle width (HWI 28.6–42.3). Dorsal and ventral "win-

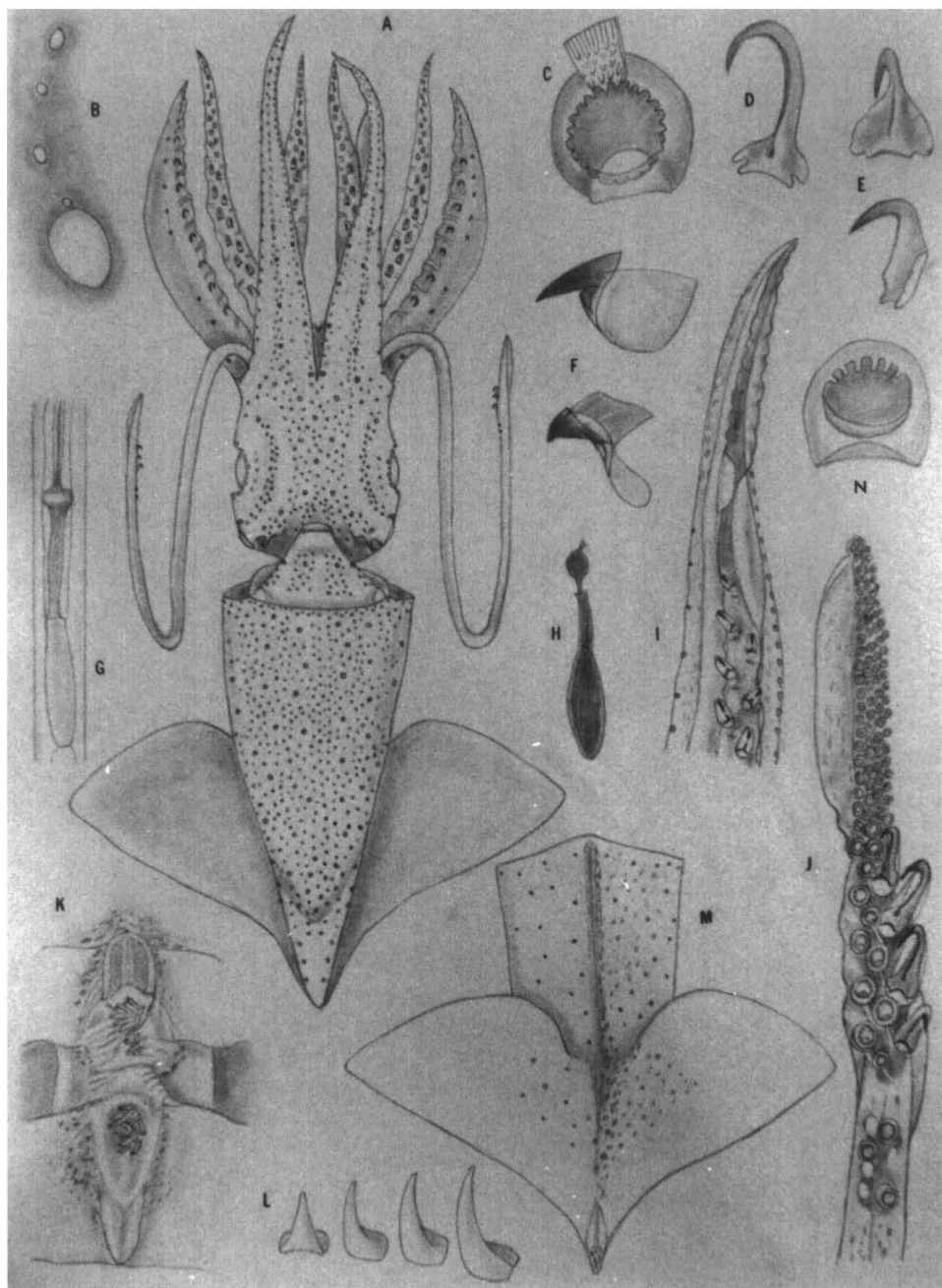


Figure 2. *Abralia heminuchalis*, new species. A. Female (holotype), ML 37 mm, ventral view, USNM 729683, HMS sta. 47-51; B. Eye light organs; C. Tentacular club sucker (manus); D. Largest tentacular club hook; E. Arm hook, 2 views; F. Mandibles, upper and lower; G. Cement gland of spermatophore; H. Ink sac; I. Hectocotylus (left arm IV), adult male (paratype), ML 32 mm, USNM 729719, HMS sta. 47-51; J. Left tentacular club; K. Seminal receptacle, adult female; L. Radular teeth; M. Mantle and fins, dorsal view, right half with both light organs and chromatophores shown; N. Arm sucker ring.

Table 3. *Abralia heminuchalis*, measurements (in millimeters), counts and indices

Cruise station	Holotype HMS 47 Sta. 51						HMS 47 Sta. 58		HMS 47 Sta. 51
Sex	F	F	F	F	F	F	F	F	M
ML	37	35	34	33	32	31	30	28	32
MWI	37.8	37.1	35.3	33.3	34.4	38.7	40.0	39.1	40.6
HWI	32.3	28.6	32.4	30.3	37.5	32.3	33.3	35.7	31.2
FLI	67.6	65.7	64.8	60.6	68.8	71.0	70.0	71.4	68.8
FWI	108.1	114.3	102.9	109.1	106.3	109.7	113.3	114.3	112.5
ALI									
I	37.3	37.1	41.2	36.4	37.5	35.5	43.3	39.2	43.8
II	40.5	42.9	44.1	39.4	43.8	41.9	46.7	42.9	46.8
III	40.5	37.1	44.1	39.4	40.6	41.9	46.7	42.9	46.8
IV	45.8	48.6	52.9	48.5	46.8	51.6	53.3	46.4	56.3
Left IV	48.6	48.6	50.0	48.5	45.2	45.2	53.3	53.4	56.3
Arm hooks									
I	15	14	13	15	15	13	17	14	15
II	15	14	15	15	15	16	18	14	15
III	14	14	14	15	12	15	14	12	15
Right-left IV	21-19	20-19	19-19	20-19	18-20	22-21	21-21	17-18	23-17
TLI	140.5	134.3	135.3	118.1	115.6	122.6	133.0	107.1	143.8
CLI	24.3	22.9	23.5	21.8	21.9	22.6	26.9	21.4	21.9
Right-left									
Club hooks	3-4	3-3	3-3	2-2	3-3	3-3	4-4	3-3	3-3
Carpal suckers	4-4	4-4	3-4	3-3	3-4	3-3	4-4	3-4	4-5

dows" extensive and thin. Buccal membrane rugose near free edge, papillose toward oral opening. Large purplish chromatophores scattered on outer surface of supports and membrane.

Arms moderate (ALI 37.0-59.5), slender, with fine delicate tips. Most common arm formula 4.2.3.1. Left arm IV of males hectocotylized (Fig. 21), devoid of distal suckers in adult stage. Biserial arm hooks triangular, apertures fused (Fig. 2E). Largest hooks on arm I, smallest on arm IV. Number of hooks on each arm fairly constant (13-17 on arms I-III, 18-21 on arm IV), fewer on hectocotylus (14-19). Except hectocotylus, distal third of arms with biserial suckers. Proximal suckers on long stalks, openings round, 6 truncate teeth on distal margin of inner ring and a narrow inner shelf (Fig 2N), progressively globular toward tip. Globular suckers absent on arms IV. Total sucker counts 30-56 on arms I, II and III and 20-25 on arm IV.

Tentacles long (TLI 92.0-145.2); club short (CLI 20.5-26.9), slender. Carpal cluster; 3-5 suckers and pads in rectangular to oval outline (Fig. 2J). Manus: 8-10 long-stalked suckers in 2 rows dorsally, 2-4 medium sized hooks on one row ventrally. Hooks with short wide base; shaft long, laterally compressed, curved and pointed (Fig. 2D). Manal suckers with about 22 pointed teeth around margin of inner ring and long pegs on outer ring (Fig. 2C). Dactylus: 17-22 quadriserial sucker rows. Thin ventral semilunar flap between carpus and third hook. Protective membrane on both sides, in form of undulating membrane on dorsal side opposite manal suckers.

Photophores and their distribution pattern closely resembles that of *A. trigonura*, except for the narrow space around the large white photophores and different

Table 3. Continued

HMS 47 Sta. 58			HMS 47 Sta. 51			HMS 47 Sta. 58			HMS 47 Sta. 51		
M	M	M	M	M	M	M	M	?	?	?	
34	30	29	28	27	26	25	20	18	17		
41.2	40	44.8	42.9	44.4	42.3	40.0	45.0	44.4	41.2		
38.2	40	34.5	31.1	37.0	42.3	36.0	30.0	27.5	35.3		
67.6	70	69.0	67.9	70.4	69.2	68.0	65.0	77.8	70.6		
102.9	106.7	117.2	114.3	114.8	115.4	104.0	120.0	122.2	105.9		
50.0	43.3	—	42.9	48.1	42.3	36.0	30.0	33.3	32.4		
52.9	50.0	51.7	46.4	51.8	46.2	40.0	35.0	38.9	41.2		
50	50.0	48.3	42.9	51.8	50.0	40.0	35.0	38.9	41.2		
58.8	53.3	58.6	50.0	59.3	57.5	44.0	45.0	44.0	50.0		
58.8	53.3	55.2	50.0	59.3	—	44.0	45.0	50.0	—		
14	17	15	15	14	14	13	5	0	0		
14	15	14	15	14	15	13	5	2	0		
14	14	13	13	14	15	12	4	0	0		
20–17	21–19	20–14	21–16	19–17	19–16	17–17	5–4	1–1	0–0		
144.1	123.3	124.1	128.6	122.2	145.2	92.0	95.0	111.1	129.4		
20.5	23.3	24.0	21.4	25.9	23.1	22.0	20.0	22.7	23.5		
2-2	3-3	3-3	3-3	3-2	3--	3-3	3-2	2-2	2-2		
3-4	3-4	3-3	3-3	3-4	3--	5-4	3-4	4-4	3-3		

position on arm III and vesiculate tail. Arm III with a dorsal row of 6–8 widely spaced light organs on basal third of arm and a ventral row along base of swimming keel; the latter with 2 light organs proximally followed by a considerable gap, then a series of 6–8 widely spaced photophores distally.

Five-eye light-organs: posterior organ largest (3 mm long), oval, dull pink; with a very small round organ (0.5 mm) adjacent. Anterior 3 organs small (1.0, 0.75, 1.2 mm), evenly spaced; anteriormost organ more elliptical than others (Fig. 2B).

Mandibles (Fig. 2F) with small notch on upper corner of wing.

Gladius with prominent sharp keel. Vanes thin, slightly thickened at free edge, origin at about $\frac{2}{3}$ of GL, anterior margin straight, posterior margin convex, lateral blunt angles at midlevel of GL. Conus blunt and shallow.

Ink sac long, duct with bulb-like swelling before entry into rectum (Fig. 2H).

Sperm reservoirs deposited on posterior half of nuchal cartilage and inner dorsal midline near gladius tip. Attachment area very rugose, not sac-like, only anterior half of nuchal cartilage visible (Fig. 2K). Freshly preserved females with elongated pigmented spot at anterior dorsal side of mantle. Eggs spherical, about 1.25 mm diameter in largest female. Oviducal glands large, protrude out of mantle in gravid females.

Spermatophore (30 mm ML male): total length 4.0 mm (SPL 13.3); sperm reservoir length 1.8 mm; cement gland length 1.0 mm, with conspicuous amber-colored swelling at oral end (Fig. 2G); spiral filament length 1.2 mm, with 2–3 coils near oral end, filament without sculpturing.

Growth.—The distinctive dull pink color and large size of the posterior eye light organ are characteristic of small specimens (7–10 mm ML). Hooks first appear

Table 4. Collecting data of *A. heminuchalis*

Cruise	Position	Year/Month	Depth (m)	Time	Number (sp.)	ML (mm)
HMS-31	01°07.0'N 149°56.0'W	1955 December	—	—	1	41
HMS-35	04°19.0'N to 15°44.0'S 142°59.8'W to 160°08.0'W	1956 September	200	—	4	26-41
HMS-47	06°06.0'N to 00°44.0'S 149°46.0'W to 150°03.0'W	1968 November	212-576	2013-2200	68	6-37
CHG-51	16°44.0'N 169°16.0'W	1961 February	0-100	2105-2323	1	26
CHG-89	09°50.3'N to 06°03.0'S 157°24.2'W to 168°06.0'W	1966 Jan.-Feb.	20-150	2038-0139	148	4-23
TC-43	12°03.0'N to 00°04.0'S 144°54.0'W to 145°09.0'W	1969 May	20-50	1940-0256	621	8-38
TC-44	07°27.2'N to 00°15.2'S 144°43.9'W to 145°2.21'W	1969 July	50-100	1932-0303	410	9-38
TC-46	07°30.0'N to 03°25.0'S 144°31.0'W to 145°05.0'W	1969 Oct.-Nov.	20-115	1931-0240	928	7-39
TC-47	07°31.0'N to 00°03.0'S 144°55.0'W to 145°06.0'W	1970 Jan.-Feb.	20-50	1930-0200	85	8-37
TC-48	07°25.0'N to 00°00.0' 144°37.0'W to 145°00.0'W	1970 April	20-50	—	175	11-40

on arm IV at 17-19 mm ML. At that size, few hooks may be present or absent on other arms. Full complement of hooks present at about 25 mm ML in both sexes. At 10 mm ML carpal suckers distinct from manal suckers. At 13 mm ML one club hook present, 2 hooks at 17 mm ML. The characteristic nuchal cartilage on females evident at about 23-25 mm ML. Sperm reservoirs first found in females at 30-31 mm ML. At 22 mm ML lappets recognizable on hectocotylus, distal suckers absent. Spermatophores absent at less than 24 mm ML. White photophores appear earliest, circular spaces around them later (15-19 mm ML) when black photophores develop.

Distribution.—Central equatorial Pacific, from 16°N to 15°S and from 144°W to 168°W.

Remarks.—Although this species can be confused with *A. trigonura*, a series of differences exists. In *A. trigonura* the most anterior of the 5-eye light-organs is larger than the median organs, in *A. heminuchalis* this organ is, at most, only as large as the middle organ (Fig. 2B). Distribution of photophores differs: in *A. heminuchalis*, 1) very distinct circular space around large white photophores present, 2) spaces between photophores on arm III of uneven length, 3) photophores on tail submarginal, more lateral in *A. trigonura*. Seminal receptacles differ in structure. A definite sac is absent, posterior half of the nuchal cartilage a rugose area (Fig. 2K). Thus, the specific name *heminuchalis* was chosen. Pigmented spot on anterior middorsal line of mantle elongate, round in *A. trigonura*. Spermatophore shorter (SPLI 13.3), longer in *A. trigonura* (SPLI 18.9). Cement gland of spermatophore with amber-colored bulb-like swelling; plain, without color, in *A. trigonura*. Size smaller, at most 37 mm ML, than *A. trigonura*, 50 mm ML. Fins wider, 100% of material with FWI greater than ML; in *A. trigonura* 50%. Counts and indices of both species overlap but means do not. Arm IV relatively longer

(ALI 59.5) than in *A. trigonura* (ALI 47.4). Arm sucker dentition differs as does the presence or absence of the notch. Distal arm suckers fewer, distinctly biserial and never crowded in *A. heminuchalis*. Club is more slender, the dorsal protective membrane more developed and fewer than 5 carpal suckers are present in this species.

A Philippine *A. andamanica* specimen described by Voss (1963) was found to possess a sac-like seminal receptacle similar to that of *A. trigonura*. K. Tsuchiya (Tokyo University of Fisheries) also found such a sac in *A. andamanica* from Japan (personal communication).

The photophore pattern of this species closely resembles *A. andamanica* (East Pacific, 5°N and 98°W) illustrated by T. Okutani (1974, fig. 3, a male). With respect to the white photophores Okutani comments, "They are always surrounded by considerably wide photophoreless space around them, . . ." The position of the seminal receptacle of E. Pacific specimens, when known, may clarify its relationship to *A. heminuchalis*.

Abralia (*Pygmabralia*) Nesis and Nikitina, 1987
Abralia (*Pygmabralia*) *similis* Okutani and Tsuchiya, 1987
 Figure 3: Tables 5, 6

Abralia similis Okutani and Tsuchiya, 1987, p. 141–150, figs. 1–15; *Abralia* n. sp., Riddell, 1985, p. 35, fig. 26 *Abralia* (*Pygmabralia*) *similis* Tsuchiya and Okutani, 1988.

Material Examined.—5 females, ML 23–27 mm, 2 males, ML 19–20 mm, HMS 47, sta. 51, 0°44'S, 149°46'W, Nov. 2, 1958, depth 576 m.—1 female, ML 17 mm, CHG 89, sta. 8, 5°56.9'S, 157°24.2'W, Jan. 31, 1966, depth 85–115 m, USNM 814411.—2 males, ML 17–19 mm, TC 43, sta. 38, 03°30'N, 145°06'W, May 20, 1969, 50 m, USNM 729697.—2 males, 17–18 mm, TC 44, sta. 54, 00°01.8'S, 145°08.9'W, July 28, 1969, depth 50 m, USNM 729695).—4 females, ML 27–30 mm, 1 male ML 20 mm, TC 46, sta. 85, 0°02'N, 144°55'W, Nov. 10, 1969, depth 20 m, USNM 729686.—2 females, 29–30 mm, TC 46, sta. 87, 00°03'N, 144°31'W, Nov. 11, 1969, depth 50 m, USNM 729706.—803 juveniles, ML 9–18 mm, TC 47, sta. 135, 00°02'S, 148°05'W, Feb. 23, 1970, depth 20 m USNM 814428.

Description.—Males smaller (17–22 mm ML) than females (17–30 mm ML). A spermatophore from 20 mm ML male had a total length of 5.2 mm (SPLI 26.0); with 2.2 mm sperm reservoir, 0.9 mm cement gland and 2.1 mm spiral filament. Cement gland simple (Fig. 3E), without color; spiral filament plain, with 2 or 3 coils at oral end. Adult females have dark pigmented seminal vesicles under collar muscle on each side of nuchal cartilage (Fig. 3M). Eggs spherical to oval, about 1.0 mm in diameter.

Growth.—The 5 small eye photophores together with the relatively plump mantle, short vesiculate tail and short fins characterize young squids. In specimens less than 10 mm ML the arms and clubs had suckers only, carpal suckers set apart, and dorsal suckers of manus distinctly larger. A 10 mm ML squid had one of the 2nd or 3rd pair of suckers transformed into hooks in arms II–IV. Additional hooks were present in older squids, but 1–2 basal suckers remain untransformed until the adult stage. The first club hook appears at 13–19 mm ML. Only 2 club hooks usually develop, 3 hooks seen only once. The basic photophore pattern is present in animals less than 10 mm ML. The hectocotylus was recognizable in specimens between 14–15 mm ML; spermatophores were absent. At 17 mm ML, the hectocotylus is fully developed and spermatophores were present. The largest male was only 22 mm ML. A female, 22 mm ML, had slightly pigmented seminal receptacles, no sperm reservoirs and an undeveloped genital system. A female, 23 mm ML, had sperm reservoirs in its receptacle.

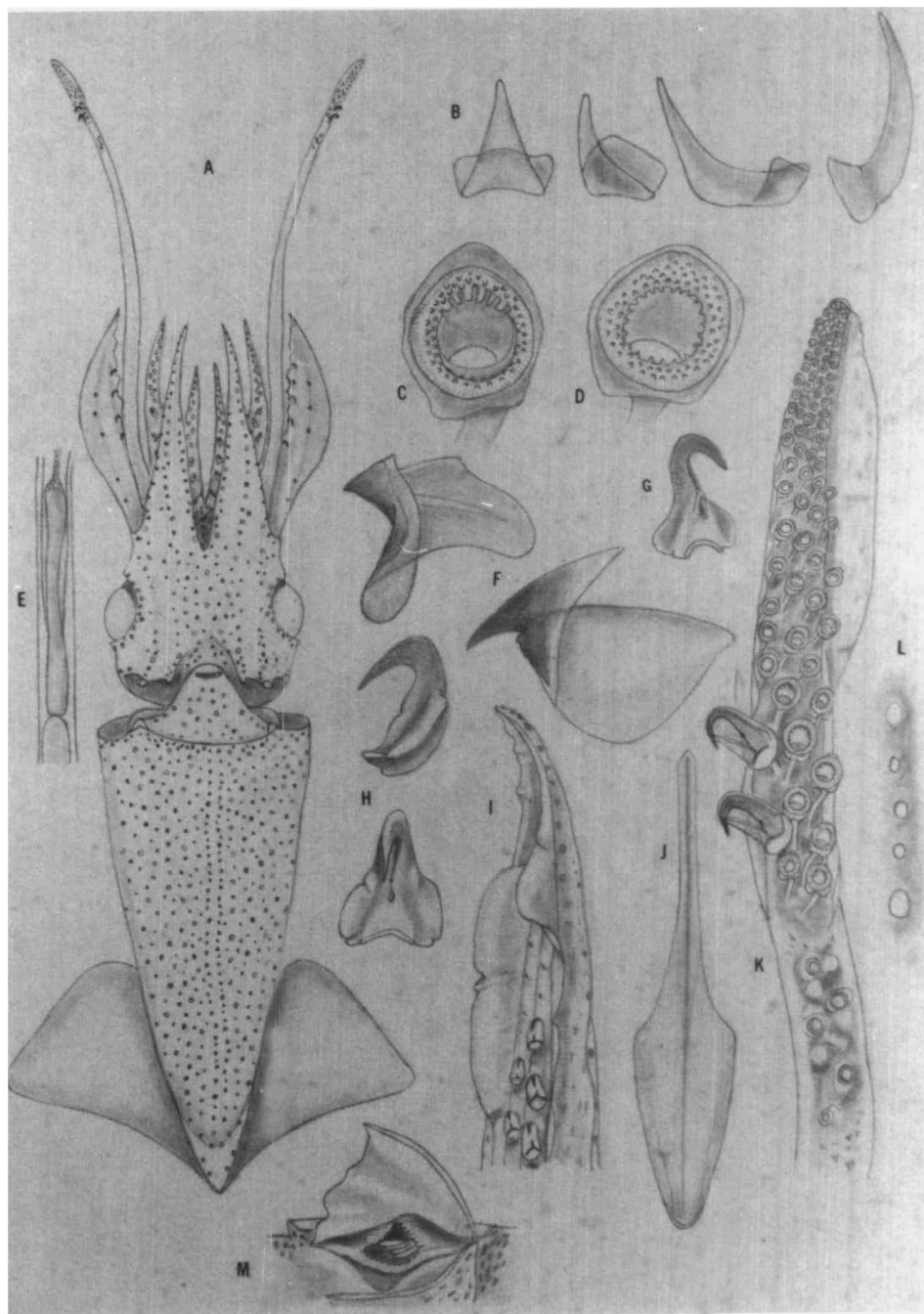


Figure 3. *Abralia similis* Okutani and Tsuchiya, 1987. A. Female, ML 38 mm, ventral view, USNM 729636, TC sta. 46-85; B. Radular teeth; C. Arm sucker; D. Tentacular club sucker (manus); E. Cement gland of spermatopore; F. Mandibles, lower and upper; G. Tentacular club hook; H. Arm hook, two views; I. Hectocotylus (right arm IV), adult male, ML 19 mm, USNM 729647, TC sta. 43-38; K. Right tentacular club; L. Eye light organs; M. Seminal receptacle, adult female.

Table 5. *Abralia similis*, measurements (in millimeters), counts and indices

Cruise station	TC 46 Sta. 85			TC 46 Sta. 85			TC 44 Sta. 86			HMS 47 Sta. 51			CHG 89 Sta. 8			TC 43 Sta. 36			TC 44 Sta. 86			TC 43 Sta. 36		
	F	F	F	M	M	F	F	F	F	F	F	F	F	F	M	M	F	F	F	F	F	F	F	F
Sex																								
ML	30	29	28	20	20	27	25	24	24	24	24	24	17	12	19	23	43.5	47.1	50.0	65.0	10	9	?	?
MWI	43.3	41.4	39.3	50.0	45.0	40.7	40.0	41.7	41.7	41.7	41.7	41.7	43.5	47.1	36.8	40.0	36.8	43.5	50.0	65.0	10	9	?	?
HWI	40.0	34.5	35.7	40.0	40.0	33.3	36.0	37.5	33.3	33.3	33.3	33.3	34.8	44.1	36.8	35.0	36.8	44.1	37.5	55.0	40.0	44.4	?	?
FLI	50.0	55.2	46.4	50.0	45.0	51.9	56.0	54.1	54.1	54.1	54.1	54.1	52.2	47.1	50.0	50.0	52.6	47.1	50.0	50.0	50.0	38.9	?	?
FWI	93.3	96.6	85.7	100.0	90.0	96.3	100.0	100.0	100.0	100.0	100.0	100.0	95.7	82.4	94.7	95.0	94.7	95.7	100.0	100.0	100.0	88.9	?	?
ALI																								
I	26.7	31.0	28.6	—	30.0	25.9	26.0	29.2	29.2	29.2	29.2	29.2	28.3	23.5	28.9	30.0	28.9	28.3	23.5	35.0	35.0	27.8	?	?
II	33.3	34.5	32.1	—	35.0	31.5	36.0	33.3	33.3	33.3	33.3	33.3	32.6	29.4	36.8	35.0	36.8	32.6	29.4	40.0	40.0	33.3	?	?
III	30.0	31.0	32.1	—	35.0	29.6	32.0	29.2	29.2	29.2	29.2	29.2	30.4	29.4	34.2	30.0	34.2	30.4	29.4	33.3	40.0	33.3	?	?
Right IV	33.3	34.5	35.7	40.0	35.0	33.3	36.0	33.3	33.3	33.3	33.3	33.3	—	35.3	42.1	40.0	42.1	—	35.3	50.0	50.0	44.4	?	?
Left IV	33.3	34.5	35.7	40.0	40.0	33.3	36.0	33.3	33.3	33.3	33.3	33.3	34.8	—	36.8	35.0	36.8	34.8	—	—	—	—	?	?
Hooks																								
I	7	7	7	7	7	8	5	6	8	8	8	6	8	4	5	6	5	8	4	0	0	0	?	?
II	9	9	9	8	8	10	8	8	10	10	10	7	9	7	6	7	6	9	7	3	1	0	?	?
III	10	7	8	7	8	10	8	10	10	10	10	6	8	6	5	6	5	8	6	0	1	0	?	?
Right IV	11	10	9	9	9	12	11	8	11	11	11	8	9	5	9	8	9	9	5	3	1	0	?	?
Left IV	10	8	10	10	10	11	11	9	11	11	11	8	11	—	10	10	11	11	—	—	—	—	?	?
TLI	66.7	82.8	57.1	70.0	110.0	70.4	76.0	75.0	95.8	95.8	95.8	90.0	95.7	82.4	78.9	90.0	95.7	95.7	82.4	120	66.7	66.7	?	?
CLI	20.0	24.1	21.4	20.0	22.5	18.5	20.0	20.8	20.8	20.8	20.8	20.0	19.6	23.5	21.0	20.0	21.0	19.6	23.5	30.0	30.0	27.8	?	?
Right-left																								
Club hooks	2-1	--2	2-2	1-1	1-1	2-2	1-2	1-2	2-2	2-2	2-2	1-1	2-1	2--	--0	1-1	--0	2-1	2--	0-0	0-0	0-0	?	?
Carpal suckers	4-4	--5	4-4	4-4	4-3	4-4	4-4	5-4	3-4	3-4	3-4	3-4	4-4	4--	--4	3-4	4-4	4-4	4--	4--	4--	4--	?	?

Table 6. Collecting data of *Abralia similis*

Cruise	Position	Year/Month	Depth (m)	Time	Number (specs)	ML (mm)
HMS-47	00°44.0'S 149°46.0'W	1958 November	576	2013-2151	67	8-25
CHG-89	00°40.5'N to 06°04.9'S 157°36.9'W to 167°43.0'W	1966 Jan.-Feb.	30-200	2057-0445	7	9-18
TC-43	03°40.0'N to 00°01.0'S 144°50.0'W to 135°06.0'W	1968 May	20-50	1940-0250	47	9-30
TC-44	03°49.9'N to 00°19.2'W 144°43.9'W to 145°21.2'W	1969 July	20-100	1932-0250	12	17-25
TC-46	03°31.0'N to 03°29.0'S 144°31.0'W to 145°06.0'W	1969 Oct.-Nov.	20-50	1931-0237	207	8-28
TC-47	07°31.0'N to 00°03.0'S 144°55.0'W to 145°06.0'W	1970 February	20-50	1930-0200	1141	8-26
TC-48	03°22.0'N 144°56.0'W	1970 April	50	—	3	19-30

Remarks.—The material examined agrees very well with the original description of *A. similis* (Okutani and Tsuchiya, 1987), except for slight difference in the proportions of the gladius. Other measurements and counts are comparable to those of the original description. Although undescribed in the original description, personal communication with Okutani and Tsuchiya confirmed the same type of seminal receptacle mentioned above is characteristic of their Northwest Pacific *A. similis* material. Riddell stated that his *Abralia* n. sp. from the Tonga Islands (Riddell 1985, p. 35, fig. 26) was conspecific with the central equatorial Pacific specimens from comparative data provided by this author (personal communication). Nesis and Nikitina (1987) considered Riddell's unnamed species as conspecific with *Abralia japonica* Ishikawa, 1929, from Toyama Bay, Japan. However, *A. japonica* was placed into the synonymy of *Watasenia scintillans* (Berry, 1911) by Tsuchiya and Okutani (1988).

Distribution.—Northwest Pacific (original description), Tonga Islands (Riddell), and central equatorial Pacific. *A. similis* seems to be of much wider distribution when the areas recorded by Nesis and Nikitina (1987) are included: western equatorial part of the Indian Ocean, central and eastern Pacific.

Abralia (*Astrabralia*) Nesis and Nikitina, 1987

Abralia (*Astrabralia*) *astrosticta* Berry, 1909

Figure 4: Tables 7, 8

Abralia astrosticta Berry 1909, p. 413; Weindl, 1912, p. 271; Berry, 1914a, p. 326, pl. 51; Voss, 1954, p. 365; Clarke, 1966, p. 171; Roper and Young, 1975, p. 11; Young, 1978, p. 589; Young and Harman, 1985, p. 185; *Abralia* (*Compsoteuthis*) *astrosticta* Pfeffer, 1912, p. 149, 161, 163; *Abralia* (*Stenabralia*) *astrosticta* Grimpe, 1931, p. 164; Nesis, 1982, p. 163, fig. 43E-G, 1987, p. 173, fig. 43E-G; *Abralia* (*Astrabralia*) *astrosticta* Nesis and Nikitina, 1987, p. 1701; Tsuchiya and Okutani, 1988, p. 126.

Material Examined.—1 male, 45 mm ML, CHG 32, sta. 32, 07°53'S, 140°00'W, Jan. 30, 1957, USNM 730629.—4 juveniles, 13-22 mm ML, TC 32, sta. 8, July 14, 1967, off Waianae, Oahu, 86-129 m, USNM 814394.—1 male, 38 mm ML, TC 32, sta. 2, off Wainae, Oahu, July 12, 1967, 65-110 m, USNM 814395.—2 males, 51-54 mm ML, 1 female, 62 mm ML, TC 40, sta. 121, 21°36.8'N, 158°11.9'W, Dec. 2, 1968, 105.6 m, USNM 730628.—3 juveniles, 31-34 mm ML, TC 8803, sta. 28, 21°21.7'N 158°09.0'W to 21°23.27'N 158°12.3'W, April 18, 1988, 105.6 m.—1 juvenile 36 mm ML,

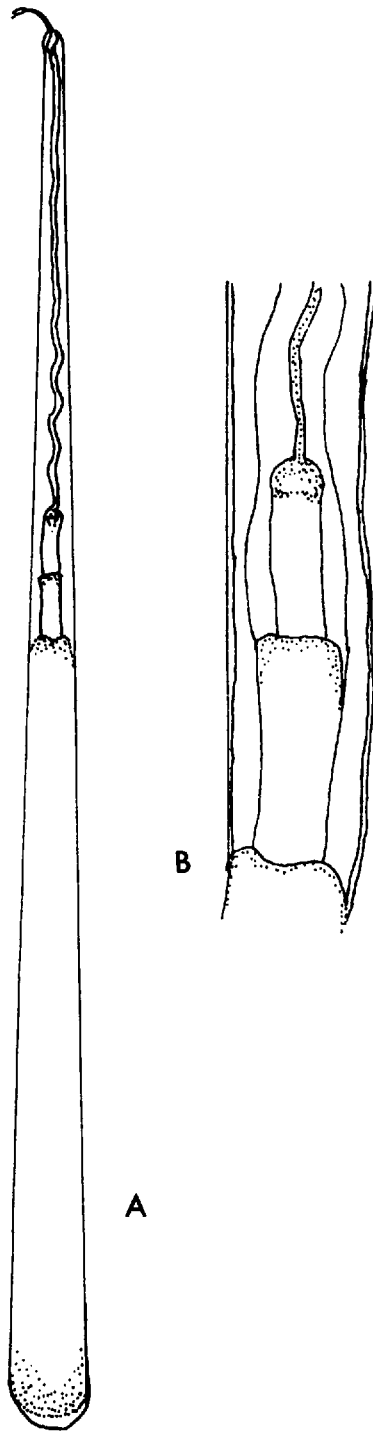


Figure 4. *Abralia astrosticta* Berry, 1909, spermatophore, adult male, ML 50 mm, USNM 730628, TC sta. 40-121. A. Complete spermatophore, 9.0 mm total length. B. Cement gland enlarged.

TC 8803, sta. 29, 21°23.95'N, 158°13.04'W to 21°21.39'N 158°08.85'W, April 18-19, 1988, 127.4 m. (Specimens from TC 8803 on loan from Dr. Richard E. Young, University of Hawaii.)

Voss (1954) identified but did not describe a single specimen in a small collection of cephalopods from Rongelap Atoll, Marshall Islands, as a female *A. astrosticta*. In an unpublished manuscript revising the genus *Abralia* and *Abraliopsis* the late Dr. Gilbert Voss described in detail this Marshall Island specimen. As a tribute to his memory, the text and illustration from his manuscript are presented here.

Abralia astrosticta Berry, 1909

Material Examined.—Female, ML 57.0 mm, from South Pass, Rongelap Atoll, Marshall Islands, collected by Birch and J. Marr, May 16, 1945, USNM 58731.

Description.—Mantle, cylindrical, widest in mid-region, tapering with concave outline to a blunt point; margin slightly produced in mid-region dorsally, excavated ventrally, with sharp lateral angles beneath funnel. Fins short, wide, anterior lobes free, anterior margin convex, posterior margin slightly concave, posterior point not drawn out in long tail. Funnel large, mostly projecting; locking apparatus straight, simple; funnel organ V shaped, double shouldered, with apical papilla and short ridge crossing anterior shoulder, ventral pads boomerang shaped with concave inner margins; funnel valve, broad, subterminal.

Head small, compact, about as wide as mantle, with small, prominent eyes; ventral surface excavated for funnel; eyelids nearly round with small distinct anterior sinus; four nuchal folds of which second from midline is olfactory crest, two ventral pads lunate, lateral and dorsal folds long, united by transverse ridge.

Arms strong, medium size, order $4.3 = 2.1$; trabeculate protective membranes on all arms, ventral deepest; I keeled on entire length, II on distal half, III deeply keeled on entire length, IV with wide sheath. I bears 17 hooks, 12 large suckers with about 18 long blunt teeth on distal margin, 19 pairs of minute ringless suckers; II bears 18 hooks, 14 large suckers and 19 pairs of minute suckers; III bears 16 hooks, 14 large and 10 minute suckers (tips of both arms partly missing); arm IV bears 19 hooks and 10 pairs of large suckers regularly increasing in size to the tip of the arm.

Tentacles short, square in cross-section with small, slightly expanded clubs; carpal cluster distinct, composed of 5 cups and 4 pads on each tentacle; manus equipped with ventral rows of 5 hooks, proximal minute, third largest; two rows of large suckers bordering hooks bearing about 30 triangular teeth, four rows of small suckers in dactylus regularly decreasing to tip. Ventral edge of club bordered by a semilunar protective membrane originating at carpus and ending near fourth hook, but extending to tip as low fold; dorsal edge with low membrane originating from carpus and extending to tip, broadest proximally, deep keel on distal three fourths of aboral surface.

Photophores of three types: 1) small and clear, 2) medium in size and dark, 3) large and clear with dark ring. Mantle with about 8 rows of large light organs on ventral surface, accompanied by small light organs not so distinctly in series, with many intervening ones; light clear streak on ventral midline, widely scattered but numerous medium light organs on dorsal surface of mantle and between fins. In addition, there are, near the posterior end of the mantle and adjacent to the fins, two large, yellowish biscuit-shaped bodies which may be photogenic. They can be found by running a probe along the side of the mantle and then rupturing the skin over them. They are homologous with the similar bodies found in *A. astrolineata* Berry, 1914b. Ventral surface of funnel with four large organs in transverse

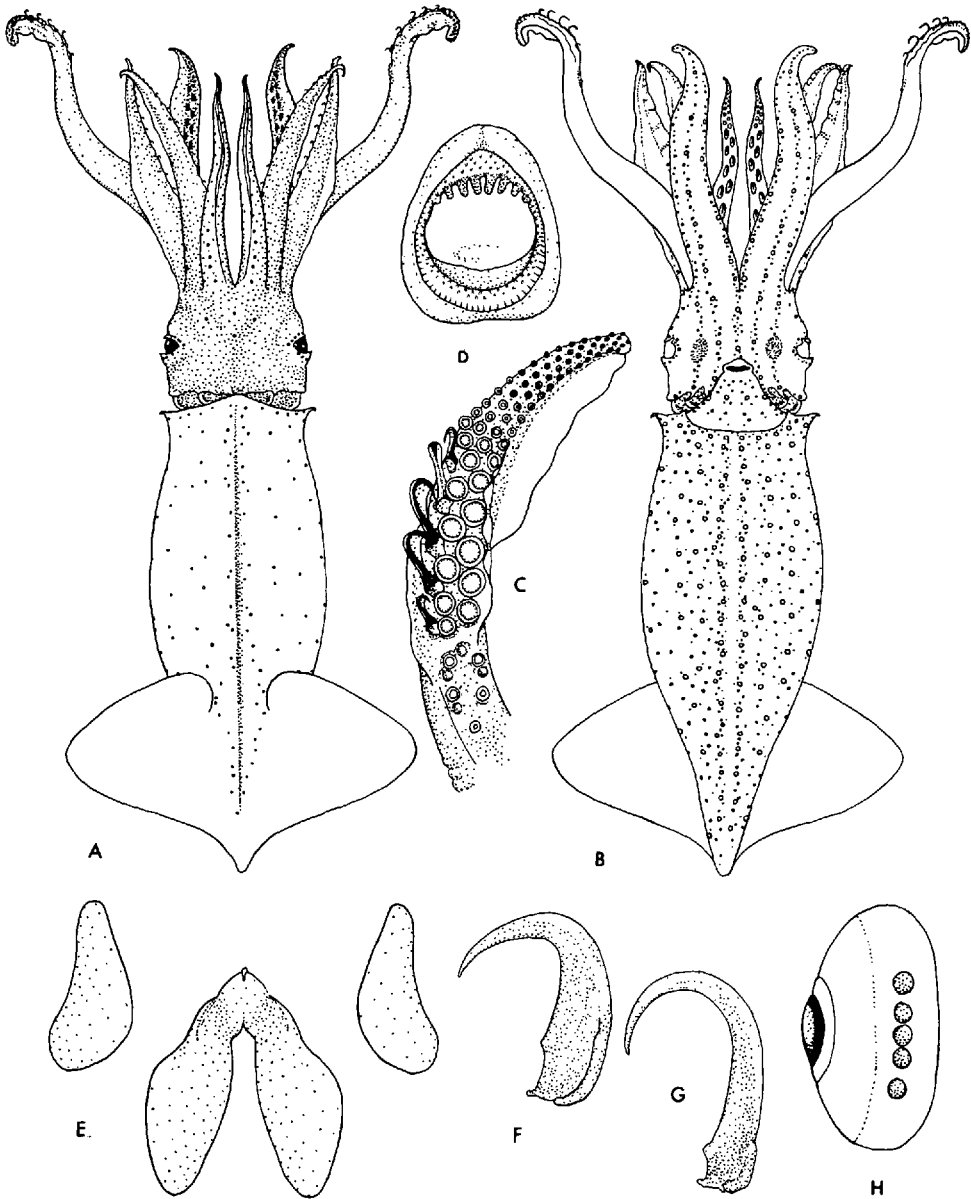


Figure 5. *Abralia astrosticta* Berry, 1909. A. Female, ML 54 mm, dorsal view, USNM 587132, from Rongelap Atoll, Marshall Islands. B. Ventral view of same female; C. Right tentacular club; D. Largest arm II sucker; E. Funnel organ; F. Largest arm II hook; G. Largest tentacular club hook; H. Eye light organ. (Figure from G. L. Voss, unpubl.)

row midway between mantle margin and tip, remaining photophores grouped symmetrically in two triangular patches. Light organs on ventral surface of head in 5 distinct, widely spaced rows with narrow circlet about each eyelid; dorsal surface of head with 4 organs forming a diamond in mid section.

Arms with light organs in regular pattern. I and II with 3–6 small light organs distributed from base outward; III with 5–6 light organs in ventral side of keel;

Table 7. *Abralia astrosticta*, measurements (in millimeters), counts and indices

Cruise station	CHG 32 Sta. 32		TC 31 Sta. 8		TC 32 Sta. 2		TC 40 Sta. 121		TC-88-03 Sta. 29		Sta. 28		Marsh. Id.		Holotype Berry	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Sex																
ML	45	22	20	15	13	38	51	54	36	34	34	33	31	34	34	34
MWI	28.9	36.4	30.0	33.3	38.5	31.6	39.2	37.0	33.9	32.4	32.4	36.4	38.7	40.7	29.4	29.4
HWI	24.4	27.3	25.0	23.3	30.8	26.3	37.3	24.1	32.5	23.8	23.8	27.3	22.6	—	26.5	—
FLI	33.3	27.3	35.0	33.3	34.6	36.8	43.1	42.6	33.3	35.3	35.3	36.4	32.3	40.1	32.4	32.4
FWI	48.9	59.1	65.0	53.3	53.8	57.9	70.6	66.7	61.1	64.7	64.7	66.7	61.3	74.1	64.7	64.7
ALI																
I	26.7	27.3	—	23.3	23.1	44.7	35.3	—	30.6	29.4	29.4	33.3	35.5	38.9	32.4	32.4
II	35.6	31.8	22.5	36.7	34.6	50.0	39.2	—	37.1	32.4	32.4	36.4	35.5	42.6	38.2	38.2
III	35.6	27.3	30.0	26.7	34.6	44.7	43.1	—	32.3	32.4	32.4	36.4	35.5	42.6	35.3	35.3
IV	47.6	34.1	30.0	30.0	34.6	47.4	47.1	—	43.5	32.4	32.4	—	38.7	48.1	38.2	38.2
Left IV	46.7	—	30.0	—	—	50.0	47.1	—	43.5	32.4	32.4	36.4	—	—	—	—
Arm hooks																
I	—	11	—	2	0	14	16	—	14	12	12	12	14	17	—	—
II	—	11	—	0	0	16	18	—	16	16	16	13	14	18	—	—
III	—	7	—	0	0	15	16	—	14	13	13	12	13	16	—	—
Right-left IV	—	—	—	0	0	15-16	14-16	—	16-18	14-15	16-16	18-17	13-13	19	—	—
TLI	—	—	80.0	46.7	92.3	126.3	113.7	—	145.2	116.7	94.1 (L)	127.3 (L)	103.2 (L)	63.0	67.6	67.6
CLI	—	—	17.5	20.0	23.1	26.3	21.6	—	22.6	19.4	17.6	21.2	19.4	11.1	11.8	11.8
Right-left																
Club hooks	—	—	0-—	0-—	0-—	4-4	5-4	—	6-—	4-5	—-5	—	—-5	5-5	5-5	5-5
Carpal suckers	—	—	4-—	—	—	3-4	4-5	—	4-—	4-—	—-4	—-4	—	—	—	—

IV with 3 rows of mixed light organs, ventral row formed on each side by bifurcation of median row of head, extending nearly to tip of arm, first lateral row of head on each side forms median row of IV, extending to extreme tip consisting 3 minutelight organs, second lateral row of head on either side forms dorsal row of IV which ends posterior to tip. Four large, deeply buried, lens like brownish bodies, not seen except by strong light through arm are found near tip and presumably are light organs.

Ventral periphery of eyeball with 5 round, equal size light organs, terminal ones slightly separate from crowded middle ones, all dark brown, terminal organs slightly lighter.

Numerous oval eggs, 1.0 mm by 0.6 mm, closely packed in ovary.

Measurements (in mm) of the specimen examined and the holotype of *Abralia astrostricta* Berry, 1909 (USNM 214313) from Hawaii are listed below:

Measurements/counts	Rongelap specimen	Holotype
ML	*54.0	34.0
MW	22.0	10.0
HW	**16.0	9.0
FL	22.0	11.0
FW	40.0	22.0
Arm Length		
I	21.0	11.0
II	23.0	13.0
III	23.0	12.0
IV	26.0	13.0
TL	34.0	23.0
CL	6.0	4.0
Hooks		
I	17	—
II	18	—
III	15	—
IV	19	—
Club Hooks(R/L)	5/5	5/5

While the above description and illustration do not exactly fit those given by Berry (1909; 1914a), I (Voss) do not hesitate to assigning the specimen definitely to *astrostricta* since all those characters used in the specific evaluation of the species it corresponds: 1) number and position of hooks on the club, 2) number, size and arrangement of photophores on the eyeball, 3) number of rows of light organs on the ventral surface of the head and 4) shape and size of the fins. Any proportional dissimilarities are probably due to changes in growth and individual variation, the specimen being much larger than the holotype. The few dorsal light organs on the head and arms I and II were not noted by Berry but could have been easily overlooked.

This species is very close to *A. astrolineata* but may be distinguished from it by the photophore pattern on the ventral surface of the mantle and the row of photophores on the dorsal arms.

Remarks (Burgess).—Indices computed from measurements of the holotype and the Marshall Island specimen of Voss are relatively close, except for the shorter club (CLI 11.5 for Marshall Id., CLI 11.8 for holotype) than the present material (CLI 17.5–26.3). This may possibly be attributed to the limited number of club length measurements. Counts are within the range of the present material.

Author's note: *a different value from original report, 57 mm ML: **possibly an error, text states, "head about as wide as mantle, . . ."

Table 8. Collecting data of *Abralia astrosticta*

Cruise	Sta. No.	Date	Position	Time	Depth (m)	Number (specs.)	ML (mm)
CHG-32	32	1/30/57	07°53.0'S, 140°00.0'W	—	—	1	45
CHG-89	32	2/20/66	03°56.0'N, 159°27.0'W	2044-2237	100-125	41	12-21
TC-31	8	5/14/67	off Waiahae, Oahu	—	—	4	13-22
TC-32	2	7/12/67	21°22.5'N, 158°13.5'W	1953-0153	65-110	15	7-38
	4	7/13/67	21°20.9'N, 158°13.1'W	1146-1746	75-107	1	7
	8	7/14/67	21°22.0'N, 158°15.5'W	1954-0154	86-129	10	11-22
	28	7/25/67	20°58.6'N, 158°33.7'W	1952-0152	7-27	4	7-27
	64	9/10/67	20°42.1'N, 156°58.1'W	0018-0318	7-13	7	8-16
	65	9/10/67	20°42.3'N, 156°56.7'W	0426-0726	101-121	3	12-17
TC-40	121	12/02/68	21°36.8'N, 158°11.9'W	0012-0200	105.6	10	49-68
TC-8803	28	4/18/88	21°21.7'N, 158°09.0'W to 21°23.27'N, 158°12.36'W	2032-2100	105.6	3	31-34
	29	4/19/88	21°23.95'N, 158°13.04'W to 21°21.39'N, 158°08.85'W	2313-2325	127.4	1	36

Additional characteristics observed: males smaller 39-54 mm ML, largest female 68 mm ML. Right ventral arm hectocotylized, with ventral lappet and smaller dorsal lappet (previously illustrated by Okutani and Tsuchiya, 1987, fig. 12). A spermatophore (Fig. 4A) from a 50 mm ML male had a length of 9 mm (SPLI 18.0), sperm reservoir 5.2 mm, cement body 0.8 mm (Fig. 4B), spiral filament 3 mm. Seminal receptacles under collar adjacent to the nuchal cartilage similar to *A. similis* (Fig. 3M).

Growth. — At 4.5 mm ML only large photophores present on mantle, funnel, head and arms. At this stage 5 closely set together eye light organs (much larger than those of young *A. similis*) and only suckers present on arms and tentacles. At 10 mm ML small photophores present. At 14 mm ML club with 4 rows of suckers on manus, carpus distinct. At 20 mm ML arms had hooks and some proximal suckers. Club hooks first observed at 21 mm ML. Characteristics of early larval stages (3.2-5.5 mm ML) observed by Young and Harman (1985).

Distribution. — Berry's holotype was collected in Hawaiian waters (off Barbers Pt., Oahu), between 192 and 352 fathoms (354-650 m) as well as most of the material examined, except for some specimens taken near the equator, near the Line Islands and Marquesas (see material examined, CHG 89, sta. 32 and CHG 32, sta. 32). The specimen described by Voss came from the Marshall Islands. The species is reported farther north and west by Tsuchiya and Okutani (1988, figs. 13-15) at 32°47.3'N and 147°58.7'E. In addition, Nesis (1982) indicates the species is found in the Philippines and the Kurushio Current.

Reid et al. (1991) consider this species to be a member of the mesopelagic boundary community in Hawaiian waters. As a land-bound species considerable potential for genetic isolation exists. Specimens from other localities, therefore, require especially careful comparison to determine whether or not they are conspecific with *A. astrosticta*.

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Finally, I greatly appreciate the assistance of Prof. N. A. Voss in granting me permission to examine *Abralia* material in the cephalopod collection of the Rosenstiel School of Marine and Atmospheric Science, University of Miami, and for the privilege of using the text and figures of *A. astrosticta* from one of the unpublished papers of her late husband and my former professor and adviser, Dr. Gilbert L. Voss.

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